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Previous research has shown that military women often experience potentially severe health outcomes following deployment. Data from the Millennium Cohort Study, a 21-year longitudinal study examining the health effects of military service, were used to examine this issue. In longitudinal analyses (2001–2008) carried out among US military women ($n = 17,481$), the authors examined positive screens for depression, anxiety, panic, and posttraumatic stress disorder in relation to deployment in support of the operations in Iraq and Afghanistan, while adjusting for relevant baseline and time-varying covariates. Women who were deployed and reported combat-related exposures had greater odds than nondeployed women of reporting symptoms of a mental health condition (odds ratio = 1.91, 95% confidence interval: 1.65, 2.20), after adjustment for demographic, military, and behavioral covariates. In addition, higher stress, problem drinking, and a history of mental illness were significantly associated with increased risk of later mental health conditions. In contrast, women in the Reserves or National Guard and those with higher education were at decreased risk of mental health conditions (all P's < 0.01). As the roles and responsibilities of women in the military expand and deployments continue, designing better prevention and recovery strategies specifically for women are critical for overall force health protection and readiness.

anxiety disorders; depression; military personnel; panic disorder; stress disorders, post-traumatic; women

Abbreviation: PTSD, posttraumatic stress disorder.

The effects of deployment on the physical and mental health of US service members continue to receive significant attention from the Department of Defense, veterans, Congress, the American public, and the media. Research has shown that deployment and combat exposures increase the risk of posttraumatic stress disorder (PTSD) (1–3), depression (4), binge drinking (1, 5, 6), and smoking (7, 8), as well as disrupted sleeping patterns (9, 10). Despite the fact that women have been involved in some capacity in every major US military conflict and that millions of biomedical research dollars have been spent to better understand the health and physical abilities of women in the military (11), prospective studies of postdeployment health among women in combat-related deployments remain sparse (12).

Previous research has suggested that women are at risk for postdeployment health issues and that their experiences may be unique (13–17). The expanded roles for women in the military have resulted in their incurring potentially toxic occupational exposures, as well as witnessing death and trauma (18). Recent findings also suggest that military women are at increased risk for postdeployment hospitalization (19) and may have less a favorable health status than men (20), demonstrating the need for deployment health research focused on women.

The Millennium Cohort Study is a population-based prospective study of US service members (21, 22) in which women were oversampled by design, making up approximately 30% of the cohort, allowing for a unique ability to

investigate any health outcomes in this important subgroup of military personnel (21). The primary aim of this study was to focus on behavioral, health, and demographic factors in a large cohort of military women during a period of high operational tempo, and to examine how these factors and deployment-related stressors may influence the onset of mental health symptoms.

MATERIALS AND METHODS

Study population and data sources

The Millennium Cohort Study surveys participants every 3 years, with an average of 2.7 years between responses, to evaluate any long-term health effects of US military service (21). In mid-2001, prior to the recent operations in Iraq and Afghanistan, a random sample of over 200,000 military personnel on active service rosters, including members of the Reserves and the National Guard (Reserve/Guard), were invited to participate in the first panel of the Millennium Cohort Study. During the 2004–2006 and 2007–2008 survey cycles, the second and third panels were enrolled, and follow-up questionnaires were completed by those previously enrolled. The Millennium Cohort is currently composed of a population-based sample of over 150,000 service members, including 48,074 women. All cohort members are voluntary participants. Further details on Millennium Cohort Study methods are available in prior publications (21–23).

The population for these analyses included Millennium Cohort women enrolled in 2001–2003 ($n = 16,876$) and 2004–2006 ($n = 6,810$) who had completed at least 1 follow-up assessment (2004–2006 and/or 2007–2008). After removing those with missing data, 17,481 women were included in our analyses. The study protocol was approved by the institutional review board at the Naval Health Research Center.

Data for this study included information collected from the Millennium Cohort questionnaire and electronic military records, provided by the Defense Manpower Data Center. Military and demographic variables, including deployment dates, sex, birth year, education, race/ethnicity, military occupation, pay grade, service branch, service component, marital status, and dual-military marriages (marriage between 2 service members), were created using information from the Defense Manpower Data Center and were backfilled using survey data to reduce missing values. All other variables, including combat experiences and the study outcomes, were assessed using self-reported data collected on the Millennium Cohort questionnaires.

Since all women included in these analyses had completed a baseline survey and 1 ($n = 8,551$) or 2 ($n = 8,930$) follow-up surveys, certain variables (combat deployment, marital status, problem alcohol drinking, and smoking status) were assessed at multiple time points and were allowed to vary over time in the models. Additionally, the models included 2 lag variables: 1) prior combat, which adjusted for self-reported combat exposures at the previous assessment, and 2) outcome at any prior assessment. To account for differences in reporting time and number of follow-up assessments, we adjusted for enrollment panel and time between assessments. All other variables were held constant at baseline.

Combat exposures, self-reported at follow-up, were defined as having personally 1) witnessed a death due to war, disaster, or a tragic event; 2) witnessed instances of physical abuse; 3) been exposed to dead or decomposing bodies; 4) been exposed to maimed soldiers or civilians; or 5) been exposed to prisoners of war or refugees. Deployment in support of the operations in Iraq and Afghanistan included all deployments after September 11, 2001, to Iraq and Afghanistan, as well as to other countries throughout the Middle East and the world related to these operations. Deployment was categorized as a 3-level variable. The "nondeployed" group included women who did not deploy between 2 assessments. Women who were "deployed without combat" had deployed between 2 assessments but did not report any combat exposures during that period, while women who were "deployed with combat" had deployed and reported combat exposures.

Life stressors, such as divorce or bankruptcy, were assessed using scoring mechanisms adapted from the Holmes and Rahe Social Readjustment Rating Scale (24). Problem drinking was assessed using the PRIME-MD Patient Health Questionnaire; participants were categorized as problem drinkers if they indicated that they had made risky decisions regarding alcohol at least twice over the last year, such as driving a car while under the influence (25). Current smokers were defined as persons who reported smoking at least 100 cigarettes in their lifetime and had not tried to quit or were unsuccessful at quitting. Pregnant and postpartum women were identified through baseline self-report of a missed menstrual period due to pregnancy or recent childbirth. Mental and physical component summary scores were assessed using validated scoring algorithms for the Medical Outcomes Study Short Form 36-Item Survey for Veterans (26, 27). A prior mental health diagnosis was defined as baseline self-report of the use of medication for anxiety, depression, or stress, or provider-diagnosed depression, schizophrenia/psychosis, manic-depressive disorder, or PTSD. Additionally, a positive screen at baseline for depression, PTSD, and anxiety disorders was included in these analyses for adjustment.

Outcomes

The main outcome for these analyses was any mental health condition. This variable was an aggregate mental health variable that identified persons who screened positive for PTSD, depression, or anxiety disorders as defined below. If a significant association between deployment experience and any mental health condition was observed ($P < 0.05$), then PTSD, depression, and anxiety disorders were examined separately in relation to deployment.

PTSD, depression, and anxiety disorders were assessed using standardized screening instruments embedded in the survey. PTSD was quantified using the PTSD Checklist–Civilian Version (28–31). A participant was defined as having PTSD symptoms according to *Diagnostic and Statistical Manual of Mental Disorders,* Fourth Edition, Text

Revision (32), criteria when at least 3 avoidance symptoms, 2 hyperarousal symptoms, and 1 intrusion symptom were endorsed at "moderate" or higher levels (28). Anxiety disorders included "other anxiety syndrome," a generalized anxiety disorder, and "panic syndrome," an anxiety disorder associated with unexpected and repeated episodes of fear along with several physical symptoms. Other anxiety syndrome, panic syndrome, and depression were identified using the PRIME-MD Patient Health Questionnaire and its standardized symptom screening algorithms (25, 33–35).

Statistical analysis

Descriptive and univariate analyses were performed to characterize the study population. Model diagnostics were used to assess collinearity between all covariates, using a variance inflation factor of 4 or greater.

The main focus of this study was to explore associations between combat deployment and any mental health outcome over time among women in the Millennium Cohort. Longitudinal multivariable modeling techniques were used, adjusting for fixed and time-varying covariates, to compare adjusted odds of reporting symptoms of any mental health condition among women who had not deployed (reference group), women who had deployed with self-reported combat exposures, and women who had deployed but did not report combat exposures. If a significant association was found in the main analysis, further analyses were planned to determine which specific mental health outcome (PTSD, depression, or anxiety disorders) was most influential in this relation.

A secondary analysis focused on the subpopulation of women who had deployed during the study time frame ($n = 4{,}906$). While adjusting for all covariates in the same manner as previously described, we added specific deployment characteristics to the model and evaluated the characteristics at each available follow-up assessment. Deployment location, multiple deployments, percentage of time deployed, and dwell time were included in this "women deployers only" subanalysis. Dwell time is a ratio comparing the number of days spent at home following a deployment and the number of days deployed. For example, if someone was deployed for 200 days and returned home for 400 days before being deployed again, his/her dwell time ratio would be 2:1. If a participant was deployed to both Iraq and Afghanistan between 2 assessments, she was categorized as having been deployed to Iraq. Percentage of time deployed was defined as the number of days deployed between assessments divided by the total number of days between assessments.

RESULTS

The distributions of baseline demographic, military, and behavioral characteristics for the study population are shown in Table 1. Approximately 25% of the women in this study were deployed during the study time frame, and of those women, about half reported combat or combat-like exposures. The majority of women were in their 30s and 40s, were married or single, had completed high school or some college, and were non-Hispanic white. At baseline, the majority of women reported their health as very good/excellent and reported low/mild stress. Approximately 15% of the population indicated a prior, provider-diagnosed mental illness, and approximately 4% screened positive for PTSD, depression, or anxiety disorders at baseline. Compared with the female population of the US military, women in the Millennium Cohort were more likely to be older, non-Hispanic white, married, in the Air Force, on active duty, officers, health-care workers, and married to another service member. Women excluded from the analyses because of missing data were more likely to be younger, non-Hispanic black, single, on active duty, in the Army, and have a high school diploma or less when compared with women who were included in the final models (data not shown).

Results from the main analysis, examining associations between combat deployment and any mental health symptoms (Table 2), underscored that deployed women who had combat exposures were significantly more likely to report symptoms of any mental health condition than women who were not deployed (odds ratio = 1.91, 95% confidence interval: 1.65, 2.20), and deployed women without combat exposures were significantly less likely to report any mental health symptoms than women who were not deployed (odds ratio = 0.82, 95% confidence interval: 0.69, 0.97). Additionally, women who reported prior combat and combat specialists had significantly increased odds of reporting mental health symptoms. Women who were previously married, those reporting moderate or worse life stressors, and those with a history of a mental health diagnosis had significantly increased odds of reporting mental health symptoms. Increasing education and Reserve/Guard component status were associated with reduced odds of mental health symptoms. Both current smoking and problem drinking were significantly associated with an increase in mental health outcomes. Additionally, postpartum and pregnant women had increased odds of reporting mental health symptoms.

Since the exposure of interest—combat deployment—was significant in the main model, further analyses assessing PTSD, depression, and anxiety disorders separately were performed. These results (Table 3) showed that, across all outcomes, women who deployed without combat exposures had significantly reduced odds of reporting mental health symptoms, while women who deployed with combat exposure had significantly increased odds of mental health outcomes when compared with women who were not deployed. The magnitude of the effect among women deployed with combat exposures was much greater for PTSD than for depression or anxiety disorders.

Subanalyses restricted to deployed women ($n = 4{,}906$) assessed combat deployment in relation to any mental health disorder (Table 4), as well as each separate condition (PTSD, depression, and anxiety disorders). Combat deployment was not significant in the models assessing any mental health condition or depression; however, it was significant in the models assessing PTSD and anxiety disorders. Prior combat exposure was highly significant for all outcomes, where women who reported combat at their

Table 1. Baseline Behavioral, Demographic, and Military Characteristics of Women in Panel 1 (2001–2003) and Panel 2 (2004–2006) of the Millennium Cohort Study as Compared With the Female US Military Population (October 2000 and October 2003)[a]

Baseline Characteristic	Millennium Cohort Women (n = 17,481)		US Military Women (n = 512,922)	
	No.	%	No.	%
Birth year				
Pre-1960	2,816	16.1	59,921	11.7
1960–1969	5,116	29.3	105,478	20.6
1970–1979	6,243	35.7	205,571	40.1
1980 or later	3,306	18.9	141,952	27.7
Race/ethnicity				
White, non-Hispanic	11,493	65.8	293,092	57.1
Black, non-Hispanic	3,084	17.6	146,521	28.6
Other	2,904	16.6	73,309	14.3
Highest educational level				
Less than high school	1,286	7.4	58,401	11.4
High school diploma/ equivalent	7,527	43.1	333,359	65.0
Some college	3,716	21.3	32,835	6.4
Bachelor's degree	3,216	18.4	61,932	12.1
Advanced degree	1,736	9.9	26,395	5.2
Marital status				
Single	7,665	43.9	280,011	54.6
Married	7,945	45.4	191,587	37.4
Divorced/widowed/ separated	1,871	10.7	41,324	8.1
Service branch				
Army	8,404	48.1	244,349	47.6
Air Force	5,422	31.0	142,048	27.7
Navy/Coast Guard	3,212	18.4	106,902	20.8
Marine Corps	443	2.5	19,623	3.8
Service component				
Active duty	8,837	50.6	242,158	47.2
Reserves/National Guard	8,644	49.4	270,764	52.8
Military pay grade				
Officer	4,270	24.4	72,115	14.1
Enlisted	13,211	75.6	440,807	85.9
Military occupation				
Combat specialist	1,088	6.2	36,557	7.1
Electronic equipment repair	1,090	6.2	27,089	5.3
Communications/ intelligence	1,340	7.7	35,629	7.0
Health care	4,108	23.5	100,837	19.7
Other technical or allied specialist	433	2.5	12,975	2.5
Functional support and administration	5,572	31.9	167,066	32.6
Electrical/mechanical equipment repair	1,012	5.8	36,116	7.0
Craft work	298	1.7	10,040	2.0
Service and supply	1,560	8.9	58,358	11.4
Student, trainee, or other	980	5.6	28,255	5.5
Dual-military family				
No	13,889	79.5	467,874	91.2
Yes	3,592	20.5	45,048	8.8
Combat deployment[b]				
Nondeployed	12,575	71.9		
Deployed, without combat	2,839	16.2		
Deployed, with combat	2,067	11.8		
Self-reported general health				
Very good/excellent	10,391	59.4		
Good	5,654	32.4		
Fair/poor	1,436	8.2		
Life stressors[c]				
Low/mild stress	13,025	74.5		
Moderate stress	3,559	20.4		
Major stress	897	5.1		
Prior mental health diagnosis[d]				
No	14,867	85.1		
Yes	2,614	14.9		
Posttraumatic stress disorder				
No	16,625	95.1		
Yes	856	4.9		
Major depression				
No	16,733	95.7		
Yes	748	4.3		
Anxiety disorders[e]				
No	16,740	95.8		
Yes	741	4.2		
Average nightly duration of sleep, hours				
<7	7,873	45.0		
7–8	7,977	45.6		
>8	1,631	9.3		
Mental component summary score[f]				
Lowest 15%	3,021	17.3		
Middle 70%	12,163	69.6		
Highest 15%	2,297	13.1		
Physical component summary score[f]				
Lowest 15%	2,882	16.5		
Middle 70%	11,966	68.4		
Highest 15%	2,633	15.1		

Table continues

Table 1. Continued

Baseline Characteristic	Millennium Cohort Women ($n = 17,481$)		US Military Women ($n = 512,922$)	
	No.	%	No.	%
Current smoking				
No	14,799	84.7		
Yes	2,682	15.3		
Problem alcohol drinking[g]				
No	16,279	93.1		
Yes	1,202	6.9		
Pregnancy or recent childbirth				
No	16,169	92.5		
Yes	1,312	7.5		

[a] All demographic characteristics of Millennium Cohort women in the study population were significantly different ($P < 0.05$) from those of the US military female population.

[b] Any deployment and combat exposures between baseline assessment and the last follow-up.

[c] History of life stress, assessed by applying scoring mechanisms from the Holmes and Rahe Social Readjustment Rating Scale (24), included items such as divorce, assault, or death of a family member.

[d] Self-report of previous provider-diagnosed manic-depressive disorder, posttraumatic stress disorder, schizophrenia/psychosis, or use of medication for anxiety, depression, or stress.

[e] Anxiety disorders included "other anxiety syndrome" and "panic syndrome," as defined by the PRIME-MD Patient Health Questionnaire (25).

[f] Assessed using the Medical Outcomes Study Short Form 36-Item Survey for Veterans (26, 27); those in the lowest 15% scored lower than 85% of the combined panel 1 and panel 2 populations.

[g] Assessed using the PRIME-MD Patient Health Questionnaire.

previous assessment had 1.83–2.74 times' greater odds of reporting symptoms of mental health disorders than women who did not report prior combat. Women who deployed to Iraq had increased odds of reporting PTSD symptoms and women who deployed to a location besides Iraq and Afghanistan had increased odds of reporting symptoms of PTSD or anxiety disorders compared with women who were not deployed at the time. Multiple deployments, percentage of time deployed, and dwell time were not significantly associated with any of the mental health outcomes.

DISCUSSION

The needs and objectives of the US military in the past decade and the changing roles and responsibilities of women in uniform have allowed for increased diversity in military occupations among women and may also have put more women in harm's way during military deployment than ever before. The objective of this large, population-based prospective cohort study was to focus on women in the military and investigate any impact of demographic, military, occupational, and health-related factors on several mental health conditions over time. This study highlighted

Table 2. Adjusted[a] Odds of Reporting Symptoms of a Mental Health Disorder[b] Among Women in the Millennium Cohort Study ($n = 17,481$), 2001–2008

Characteristic	Odds Ratio	95% Confidence Interval
Combat deployment[c]		
Not deployed	1.00	
Deployed, without combat	0.82	0.69, 0.97
Deployed, with combat	1.91	1.65, 2.20
Prior combat[c]		
No	1.00	
Yes	1.74	1.41, 2.16
Birth year[d]		
Pre-1960	1.00	
1960–1969	1.02	0.86, 1.19
1970–1979	1.13	0.96, 1.34
1980 or later	1.03	0.82, 1.30
Race/ethnicity[d]		
White, non-Hispanic	1.00	
Black, non-Hispanic	1.15	1.01, 1.31
Other	1.08	0.94, 1.24
Highest educational level[d]		
Less than high school	1.00	
High school diploma/equivalent	0.87	0.72, 1.04
Some college	0.81	0.65, 1.00
Bachelor's degree	0.61	0.48, 0.78
Advanced degree	0.54	0.40, 0.75
Marital status		
Single	1.00	
Married	1.08	0.95, 1.22
Divorced/widowed/separated	1.27	1.10, 1.47
Service branch[d]		
Army	1.00	
Air Force	0.63	0.55, 0.72
Navy/Coast Guard	0.78	0.67, 0.90
Marine Corps	0.79	0.60, 1.05
Service component[d]		
Active duty	1.00	
Reserves/National Guard	0.88	0.79, 0.98
Military pay grade[d]		
Enlisted	1.00	
Officer	0.84	0.69, 1.03
Military occupation[d]		
Functional support and administration	1.00	
Combat specialist	1.42	1.15, 1.76
Electrical repair	1.16	0.94, 1.44
Communications/intelligence	1.08	0.88, 1.31
Health care	1.08	0.94, 1.24
Other technical or allied specialist	1.19	0.87, 1.63

Table continues

Table 2. Continued

Characteristic	Odds Ratio	95% Confidence Interval
Electrical/mechanical equipment repair	1.07	0.86, 1.33
Craft work	1.39	1.00, 1.93
Service and supply	1.24	1.05, 1.48
Student, trainee, or other	1.31	1.05, 1.64
Self-reported general health[d]		
Very good/excellent	1.00	
Good	1.23	1.10, 1.38
Fair/poor	1.38	1.15, 1.64
Life stressors[d,e]		
Low/mild stress	1.00	
Moderate stress	1.59	1.42, 1.78
Major stress	2.06	1.73, 2.45
Prior mental health diagnosis[d,f]		
No	1.00	
Yes	1.64	1.45, 1.85
Any prior mental health symptoms		
No	1.00	
Yes	2.10	1.71, 2.58
Posttraumatic stress disorder[d]		
No	1.00	
Yes	1.35	1.10, 1.66
Major depression[d]		
No	1.00	
Yes	1.06	0.86, 1.31
Anxiety disorders[d,g]		
No	1.00	
Yes	1.57	1.27, 1.93
Average nightly duration of sleep, hours[d]		
<7	1.18	1.06, 1.32
7–8	1.00	
>8	1.21	1.02, 1.43
Mental component summary score[d,h]		
Lowest 15%	2.15	1.89, 2.45
Middle 70%	1.00	
Highest 15%	0.68	0.56, 0.82
Physical component summary score[d,h]		
Lowest 15%	1.58	1.39, 1.79
Middle 70%	1.00	
Highest 15%	0.84	0.73, 0.98
Current smoking		
No	1.00	
Yes	1.16	1.03, 1.32
Problem alcohol drinking[i]		
No	1.00	
Yes	2.50	2.13, 2.93
Dual-military family[d]		
No	1.00	
Yes	0.88	0.77, 1.00
Pregnancy or recent childbirth[d]		
No	1.00	
Yes	1.22	1.02, 1.46

[a] Results were adjusted for all variables in the table, plus panel and time between the follow-up and baseline assessments.
[b] From 2004 to 2008, 2,310 women reported symptoms of any mental health disorder.
[c] Combat was defined as a self-report of having personally experienced combat or a combat-like situation, such as witnessing a person's death due to war, disaster, or a tragic event.
[d] Assessed only at baseline.
[e] History of life stress was assessed by applying scoring mechanisms from the Holmes and Rahe Social Readjustment Rating Scale (24).
[f] Self-report of previous provider-diagnosed manic-depressive disorder, posttraumatic stress disorder, schizophrenia/psychosis, or use of medication for anxiety, depression, or stress.
[g] Anxiety disorders included "other anxiety syndrome" and "panic syndrome," as defined by the PRIME-MD Patient Health Questionnaire (25).
[h] Assessed using the Medical Outcomes Study 36-Item Short-Form Health Survey for Veterans (26, 27); those in the lowest 15% scored lower than 85% of the combined panel 1 and panel 2 populations.
[i] Assessed using the PRIME-MD Patient Health Questionnaire.

Table continues

consistency in increased odds of symptom reporting for PTSD, anxiety disorders, and depression in relation to reported combat-related exposures. Also noteworthy was consistency in reduced odds of these outcomes for deployed women not reporting combat exposures. Other risk factors, including increased stress, poor sleep, problem alcohol drinking, and smoking, were associated with increases in mental health symptoms, which is consistent with previous literature (4, 6, 10, 36–38).

Although finding an increased risk of depression among women exposed to combat is not novel (4), this is the first study to find increased risk of any mental health symptoms, PTSD, or anxiety disorders among deployed women who reported combat-related experiences when compared with nondeployed women. Concurrently with our findings, investigators in 2 other studies have reported an increase in mental health disorders, including PTSD, anxiety, and depression, among women who deployed compared with women who did not deploy (16, 39). Our study also found reduced odds of mental health symptoms among those who deployed without combat (2, 4). While these findings may seem counterintuitive, they probably represent a selection process for deploying relatively young, fit, healthy individuals (i.e., unhealthy persons are less likely to be selected for deployment) (13). Furthermore, deployment in the absence of exposure to combat seems to entail little risk of mental health disorders and is often seen to be protective of

Table 3. Adjusted[a] Odds of Reporting Symptoms of a Mental Health Disorder[b] Among Women in the Millennium Cohort Study, 2001–2008

Combat Deployment Status[c]	PTSD		Depression		Anxiety Disorder[d]	
	OR	95% CI	OR	95% CI	OR	95% CI
Not deployed	1.00		1.00		1.00	
Deployed without combat	0.78	0.62, 0.96	0.77	0.61, 0.98	0.76	0.60, 0.96
Deployed with combat	2.32	1.96, 2.74	1.55	1.27, 1.90	1.78	1.48, 2.14

Abbreviations: CI, confidence interval; OR, odds ratio, PTSD, posttraumatic stress disorder.

[a] Results were adjusted for all variables in the table, plus panel, race/ethnicity, education, military pay grade, military occupation, mental component summary score, physical component summary score, smoking status, age, service branch and component, alcohol-related problems, life stressors, sleep, prior mental health diagnoses, dual-military families, pregnancy or recent childbirth, marital status, baseline symptoms of PTSD, depression, anxiety, or panic syndrome, prior symptoms of any mental health condition, self-rated general health, and time between the follow-up and baseline assessments.

[b] From 2004 to 2008, 1,498 women reported symptoms of PTSD, 1,166 reported symptoms of depression, and 1,329 reported symptoms of anxiety disorders.

[c] Combat was defined as a self-report of having personally experienced combat or a combat-like situation, such as witnessing a person's death due to war, disaster, or a tragic event.

[d] Anxiety disorders included "other anxiety syndrome" and "panic syndrome," as defined by the PRIME-MD Patient Health Questionnaire (25).

postdeployment mental health in light of the deployer selection process. As shown in previous studies, often deployment itself is not a predictor of negative mental health outcomes; rather, combat exposures seem to involve the most risk (2, 4, 10, 40).

Although Department of Defense policy generally excludes women from direct combat roles, both the nature and the extent of women's roles and responsibilities in the military have greatly evolved since the Vietnam War (38). As active members of combat support units, women are exposed to hostile fire, improvised explosive devices, and other combat-related traumas while working side by side with men. In fact, Department of Defense statistics reveal that as of 2009, 634 women had been wounded in action and 121 women had been killed in action supporting the conflicts in Iraq and Afghanistan (38). In contrast to historical models of war, where 2 enemy forces opposed each other at a forward line of battle, for current military combat deployments there are less clear front lines of engagement—causing service members, including women, to be exposed to combat in areas or occupations beyond traditional combat-related environments. Women currently serve as intelligence analysts, combat trauma health-care specialists, combat specialists (such as combat engineers and base security personnel), and service and supply handlers (such as transportation units or law enforcement officers), among other occupational specialties. These occupations clearly have the potential for combat-related exposures, increasing the risk of PTSD and other mental health disorders following deployment. The category "students, trainees, and other occupations" may include patients, prisoners, students, and persons in undesignated occupations. These participants may also be at increased risk for mental health disorders due to stresses related to school, illness, or prison rather than combat.

This study found that women in the Reserves or National Guard were at decreased risk of mental health disorders compared with active-duty women. This result held true in models for all mental health disorders, including those models restricted to female deployers only. This finding is supported by a previous investigation of depression in the Millennium Cohort wherein active-duty women were at increased risk of new-onset depression compared with women in the Reserve/Guard (4), as well as another study conducted in the Canadian military wherein reservists were less likely to have social anxiety disorder (41). One potential explanation is that active-duty women may more often have prolonged or repeated exposure to sexual harassment and trauma—risk factors for mental disorders—than women serving in the Reserve/Guard (38, 42, 43).

Several findings of this study underscore the importance of the family context for women serving in the military. Women who were divorced, widowed, or separated had increased odds of screening positive for a mental health condition. This finding is supported by literature demonstrating that divorce, widowhood, and a lack of social support may be related to increased risk of mental illness (44–47). Additionally, women who were pregnant or postpartum at baseline had increased odds of mental health disorders. Undoubtedly some of the effect was due to postpartum depression, but there is a notable research gap on the effects of military-induced maternal separation on a mother, highlighting an area for future research and follow-up. Given that mothers in many families bear primary responsibility for coordinating and providing care for their children, it may be particularly important for health-care providers and policy-makers to understand the possible social implications of deploying these women.

Not surprisingly, findings also indicated a strong relation between alcohol-related problems and screening positive for any mental health disorder. Previous studies have shown a significant association between alcohol-related

Table 4. Adjusted[a] Odds of Reporting Symptoms of a Mental Health Disorder[b] at Follow-Up Among 4,906 Deployed Women in the Millennium Cohort Study, 2001–2008

Deployment Characteristic	Any Mental Health Disorder[c]		PTSD		Depression		Anxiety Disorder[d]	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Combat deployment status[e]								
Not deployed at the time[f]	1.00		1.00		1.00		1.00	
Deployed without combat	0.60	0.35, 1.02	0.40	0.23, 0.71	0.69	0.35, 1.36	0.51	0.27, 0.95
Deployed with combat	1.40	0.82, 2.37	1.15	0.66, 2.00	1.37	0.69, 2.70	1.28	0.68, 2.39
Prior combat[e]								
No	1.00		1.00		1.00		1.00	
Yes	1.83	1.41, 2.38	2.09	1.55, 2.82	2.16	1.58, 2.96	2.74	2.08, 3.61
Deployment location								
Not deployed at the time[f]	1.00		1.00		1.00		1.00	
Iraq	1.42	0.81, 2.49	2.08	1.13, 3.81	1.29	0.64, 2.60	1.84	0.95, 3.55
Afghanistan	1.30	0.68, 2.48	1.41	0.68, 2.91	1.08	0.46, 2.52	2.15	0.99, 4.64
Location other than Iraq or Afghanistan	1.45	0.86, 2.45	1.83	1.06, 3.17	1.21	0.62, 2.39	1.95	1.05, 3.65
Multiple deployments								
No	1.00		1.00		1.00		1.00	
Yes	0.91	0.64, 1.30	0.99	0.67, 1.46	0.99	0.62, 1.57	0.87	0.56, 1.36
Percentage of time deployed[g]								
0–20	1.00		1.00		1.00		1.00	
21–35	1.08	0.85, 1.38	1.14	0.86, 1.51	1.03	0.73, 1.44	0.90	0.66, 1.24
36–50	1.22	0.86, 1.73	1.38	0.94, 2.03	1.09	0.66, 1.79	1.23	0.80, 1.91
> 50	0.89	0.40, 2.01	0.81	0.31, 2.14	0.53	0.15, 1.85	0.70	0.25, 1.98
Dwell time[h]								
Other	1.00		1.00		1.00		1.00	
<1:1	1.01	0.57, 1.78	0.92	0.48, 1.76	1.41	0.70, 2.86	0.91	0.41, 2.02

Abbreviations: CI, confidence interval; OR, odds ratio; PTSD, posttraumatic stress disorder.

[a] Results were adjusted for all variables in the table, plus panel, race/ethnicity, education, military pay grade, military occupation, mental component summary score, physical component summary score, smoking status, age, service branch and component, alcohol-related problems, life stressors, sleep, prior mental health diagnoses, dual-military families, pregnancy or recent childbirth, marital status, baseline symptoms of PTSD, depression, anxiety, or panic syndrome, prior symptoms of any mental health condition, self-rated general health, and time between the follow-up and baseline assessments.

[b] From 2004 to 2008, 720 women reported symptoms of any mental health condition (PTSD, depression, anxiety, or panic syndrome), 491 women reported symptoms of PTSD, 342 women reported symptoms of depression, and 397 women reported symptoms of anxiety disorders.

[c] "Any mental health disorder" included PTSD, depression, anxiety, and panic syndrome.

[d] Anxiety disorders included "other anxiety syndrome" and "panic syndrome," as defined by the PRIME-MD Patient Health Questionnaire (25).

[e] Combat was defined as a self-report of having personally experienced combat or a combat-like situation, such as witnessing a person's death due to war, disaster, or a tragic event.

[f] The reference group, "not deployed at the time," included women who were deployed during the study period but were not deployed during one of the follow-up waves.

[g] Percentage of days deployed between assessments.

[h] Ratio of the number of days spent at home following a deployment to the number of days deployed.

problems or alcohol misuse and combat deployment (3, 5, 48, 49), but these reports were not focused on women. Studies that have examined women separately have also found positive associations between alcohol misuse and mental health disorders, especially depression and PTSD (4, 36). While men are known to misuse alcohol more than women (50, 51), these results provide further evidence that health-care providers and military leaders should also be vigilant for alcohol-related problems among women experiencing mental health symptoms.

There were limitations to this study. The Millennium Cohort is a stratified random sample of personnel serving in the US military at the time of enrollment. Although previous research has shown the Millennium Cohort to be well

representative of the US military (21, 22, 52, 53), the current study's sample of women differed with regard to some characteristics from all women serving in the US military. Most of the differing characteristics, such as older age and more education, are those commonly found to be associated with higher survey response (53). Self-reported survey data can under- or overrepresent the true prevalence of an exposure or outcome; however, previous research on this cohort has shown participant data to be valid and reliable (18, 54–57). Additionally, while many reported odds ratios were statistically significant, the strength of the associations was often less than 2-fold. Although standardized instruments were used as screening tools for PTSD, depression, anxiety, and panic disorders, and these instruments have been shown to correlate well with a physician's diagnosis (25, 28, 33, 35), misclassification of some cases may have occurred. The combat definition included items representative of exposures that may occur during combat, but they may also occur in a situation entirely unrelated to combat. A sensitivity analysis demonstrated that the strength and direction of adjusted odds did not significantly change when combat was rescored after removing the item describing "witnessing instances of physical abuse."

Despite these limitations, the study also had several noteworthy strengths. While the US military is composed of approximately 15% women, female service members were oversampled in the Millennium Cohort Study and represent approximately 30% of the Millennium Cohort. The study population includes women from all service branches, Reserve/Guard members, and women who have separated from the military. These attributes allow for greater generalizability of these findings across female service members and veterans. Finally, an examination of nonresponse bias in the Millennium Cohort found that prospective analyses in this cohort are not substantially biased by nonresponse (58).

In summary, we believe this to be the first large, prospective study describing risks for mental health challenges in military women who have served in the current era. Women with reported combat exposures were more likely to have mental health symptoms than women who deployed without combat-associated exposures and women who never deployed. Additionally, we found that active-duty women and mothers of young children had increased odds of mental health disorders. Future analyses of the Millennium Cohort and its related family study component (59) will help to identify longer-term effects of military occupations and other exposures on women, beyond mental health outcomes. Findings from such research are expected to be extremely valuable to women, families, and public health policy-makers, both within the military and in the general population.

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14. ABSTRACT

Previous research has shown that women often experience different types and severity of health outcomes following deployment compared with men. This longitudinal study examines the effects of deployment on the self-reported mental health of women in the Millennium Cohort from 2001-2008. Women who deployed in support of operations in Iraq and Afghanistan and reported combat-related exposures had significantly higher odds (odds ratio = 1.88, 95% confidence interval: 1.62, 2.18) of reporting mental health symptoms than nondeployed women, after adjusting for demographic, military, and behavioral covariates. Also, reporting less than 7 hours of sleep or more than 8 hours in an average 24-hour period, higher stress, problem drinking, and the presence of mental health conditions prior to the baseline assessment were significantly associated with an increased risk for later mental health conditions. In contrast, women with higher education levels and those in the Reserves/National Guard were at decreased risk for mental health conditions (all *P* values <0.01). As the roles and responsibilities of women in the military expand and deployments become more common among female service members, designing better prevention strategies to address any health outcomes unique to this population are critical for overall force health protection and readiness.

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